ELECTRO-ALLOTROPO-PHYSIOLOGY.

USES OF

DIFFERENT QUALITIES

OF

ELECTRICITY TO CURE DISEASE.

By JEROME KIDDER, M. D.

[2. ed.?]

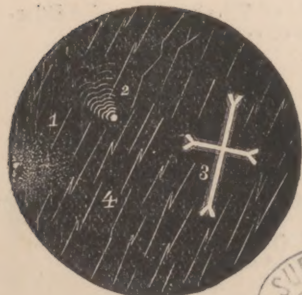

Fig. 10.

Fig. 5.

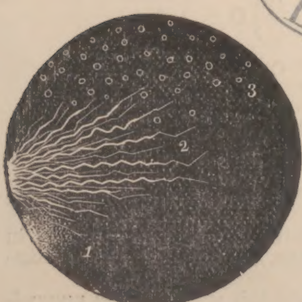

Fig. 3.

Fig. 12.

NEW YORK:

ELECTRO-ALLOTROPO-PHYSIOLOGY.

Uses of Different Qualities of Electricity to Cure Disease.

Exceedingly interesting, as far as it can be understood, is the manner in which certain qualities of electricity advance vital processes and so aid nature in the cure of disease.

In examining this subject, let us consider the great law of *allotropism*, and (its allied term) *isomerism*, the former expressing the difference between bodies identical in composition, and the latter predicating identity of composition between different bodies.

There are many examples of the same elements forming different substances. Acetic acid, lactic acid, and grape sugar are each formed of the ultimate proportions of one part carbon, two of hydrogen and one of oxygen, as expressed by the following formulas:

Acetic Acid, $2\,(C\,H^2\,O) = C^2\,H^4\,O^2$
Lactic Acid, $3\,(C\,H^2\,O) = C^3\,H^6\,O^3$
Grape Sugar, $6\,(C\,H^2\,O) = C^6\,H^{12}O^6$

Butyric acid, Acetic ether, Aldehyde and Oxyde of Ethylene are quite different substances, yet they have the same percentage of composition, viz:

Carbon,	54.55
Hydrogen	9.09
Oxygen	36.36
	100.00

Their composition is expressed by these formulas:

Butyric Acid	$C^4\ H^8\ O^2$
Acetic Ether	$C^4\ H^8\ O^2$
Aldehyde	$C^2\ H^4\ O$
Oxyde of Ethylene	$C^2\ H^4\ O$

Butyric Acid. $\left.\begin{matrix} C^4\ H^7\ O \\ H \end{matrix}\right\}O$

Acetic Ether $\left.\begin{matrix} C^2\ H^3\ O \\ C^2\ H^5 \end{matrix}\right\}O$

Aldehyde $\left.\begin{matrix} C^2\ H^3 \\ H \end{matrix}\right\}O$

Oxyde of Ethylene $(C^2\ H^4)\ O$

Oxygen exists in two allotropic states; in one it is ordinary oxygen, and in the other it is ozone, which is called active oxygen, as it more readily decomposes many substances.

Iron exists in two allotropic states, in one of which it simulates the unoxydable character of gold or platinum; and in the other state it is common iron, being very readily oxydable.

Charcoal, plumbago and the diamond, are only carbon existing in different allotropic states, causing them to differ as to their specific gravity, their conduction of heat and electricity, their power of absorbing, reflecting and transmitting light, and also in their relations to oxygen; for there are varieties of charcoal which spontaneously take fire in the air, while the diamond can be burned only in pure oxygen.

The peculiar state of bodies may be retained when they unite with other bodies to form compounds. So carburetted hydrogen and otto of roses, which have the same ultimate composition, may differ, as Millon suggests, in the one containing charcoal carbon, and the other, diamond carbon. If carbon and hydrogen unite, it is possible we may have three different compounds—one containing charcoal carbon, a second plumbago carbon, a third diamond carbon, or if we designate these respectively *Ba Cp Cy*, we may have for their formulas, C*a* H, C*p* H, C*y* H.

Influences change an Element.

Influences change an element from one allotropic condition to another, and new chemical changes result therefrom. Sparks of electricity through the air change a portion of the oxygen to ozone. Oxygen set free from water by the galvanic battery is often in a similar state. The indigo ray by itself, or existing in light changes chlorine from the passive to the active condition, as instanced by its causing chlorine and hydrogen to unite with an explosion. Contact with spongy platinum has the same effect on these mixed gases. Pure chlorine gas expanded by heat, condenses again on cooling, but expanded by blue and violet light, retains its expanded bulk permanently. The expansion is not more than one-tenth as great when submitted to red rays, which shows that it is not the heat of the ray, but the quality of the ray itself that causes the expansion.

Iron, by a simple process, which any one can perform, (as will be shown farther on,) assumes the nature of gold or platinum as far as its oxydable character is concerned, and can as readily be thrown back to the nature of common iron. Thus two pieces of iron may be conditioned so as to compose the elements of a galvanic battery, one answering to the platinum, and the other to the zinc.

The basis of the physiological vital processes are the chemical affinities with their *allotropic variations*, without which there could be no contraction of muscle, no action of the brain, no mental wakefulness; nor even could there be sleep, for sleep is a condition in which the vital process of recuperation takes place—a restoration by means of a particular relation of the chemical affinities governed by special *allotropic* conditions of the elements of repair. When the mind has been very active, there is increased elimination of the products of waste of brain material, principally the oxydized compounds of phosphorus.

Also, when there has been great muscular activity, there is increased elimination of the products of muscular waste,—urea, the oxydized compounds of sulphur, carbon, etc.

To repair the wearing constitution, digestion, which is a regulated chemical action, takes place within the organs designed for this process. But digestion could take place, *in a certain degree*, without the agency of the nervous system, yet it can not be denied that certain nerves preside over that function, for it is well known that a genial condition of the mind aids digestion, while fear or a depressed state of the nervous system, interferes with nutrition, circulation and digestion.

With regard to muscular contraction this law also applies. For though motor nerves preside over the contraction of the muscles, yet this power of contraction exists in muscular fibre, causing it to contract from other external stimuli, independent of and without regard to the presiding influence of nerves. In some of the lower animals, muscular fibre is distinct, not connected with nerves, as in the vorticelli and infusoriæ. This inherent irritability of muscular fibre is designated by different terms, viz: *Vis Irritabilitatis*, Vis Vitæ, *Vis Insitæ* of Haller, *Vis Vitalis* of Gorter, *Oscillatio* of Bœerhaave, *Tonic Power* of Stahl, *Vita Propria*, Irritabilitas Halleriana, *Inherent Power*, Excitability, etc. This power of inherent responsive movement, when acted upon by external stimuli, is a vital property which belongs to all living organized beings. Notwithstanding the inherent irritability of muscular fibre, it is still more familiar to general knowledge that the nerves, also influenced by the will, have the power to cause these contractions.

As regards mental processes, the will, through the nervous system, to a great extent, determines how great shall be the action of the brain, and therefore, to a

certain extent, decides when those elements—phosphorus and oxygen—shall possess the allotropic conditions, giving them affinities which cause them to go into that manner of union which supports processes of reasoning and calculation.

Also, the will, through the nervous system, determines how great and of what character shall be the action of the muscles, and therefore, through the nervous system, decides when those elements—sulphur, carbon, hydrogen, nitrogen, oxygen—existing in the organized muscle, shall be modified in their allotropic conditions to have such affinities that their consequent unions contract the muscle, yielding urea, creatine, extractives, etc., which, in their further changes, are resolved to urea, sulphuric, carbonic acids, etc.

Electricity closely Allied to the Nervous Influence.—Construction of an Artificial Nerve.

Though electricity is not itself the nervous influence, they are closely allied. They differ in rate and character of conduction. Electricity moves at the rate of about 288,000 miles per second, while the nervous influence moves at the rate of about 111 feet per second, more or less, according to modifying conditions.

Now let us construct an artificial nerve, and observe how it behaves on applying certain kinds of stimuli which excite the nerves in a living body.

Here are three test tubes, nearly filled, the first with nitric acid, specific gr. 1.399, the second with nitric acid sp. gr. 1.375, the third with nitric acid sp. gr. 1.250.

1. Into the tube containing nitric acid sp. gr. 1.399 I place a wire or small rod of iron.

2. Now the nerve of an animal consists of an external sheath, the neurilemma, corresponding to the glass tubes, as far as its use is as a vessel to contain the working matter. Next there is the medullary substance, called the white substance of Schwan, which is an albuminoid body, (in which exist the constituents of nitric acid,) corresponding to the liquid in these tubes.

In the centre, surrounded by the white substance, is the axis cylinder or band corresponding to this wire or rod of iron in the solution contained in the tube.

Though iron is usually active, readily decomposing in nitric acid, yet this wire, after slight action at first, has become perfectly passive, no action whatever taking place, as though it were platinum or gold. Fig. 1.

Fig. 1.—Nitric Acid, sp. gr. 1.399.

Fig. 2.—Nitric Acid, sp. gr. 1.375.

We now place this wire in the nitric acid, sp. gr. 1.250, and it is still passive, but if it had been *first* placed in this same acid it would have been active. We now dip into this same solution another wire, a common iron wire, which is active; a brown substance gathers upon it, and immediately small bubbles begin to rise from it. With this latter wire we touch the former inactive

wire, and immediately it is changed to its common condition, and chemical action commences upon that also. There was no perceptible lapse of time in which the changed condition progressed from the point touched to the more remote parts, as action by the acid appeared to the eye to be simultaneous upon all parts of it. Fig. 3.

No. 3.—Nitric Acid, sp. gr. 1.250.

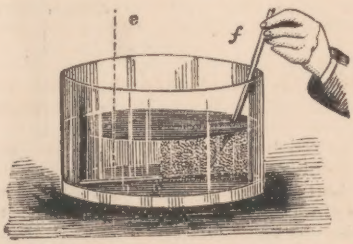

Fig. 4.—Nitric Acid, sp. gr. 1.399.

But under modified conditions the allotropic change progresses more slowly, showing its movement plainly. We will first change the wire back to its former passive state by associating it with a wire of platinum, or with another wire already in the passive state, and *gradually* introducing them into the acid, sp gr. 1.399, the platinum, or the inactive wire, extending lower so as to go in *first.* Observe that this wire has again become passive, no chemical action taking place. But on placing it in the second tube of acid, specific gravity 1.375, and touching it with an active wire, activity begins first at the part touched, and thence progresses onward, till the whole has become active. Fig. 2.

Again making this wire passive as before, we place it in the tube No. 1, where we make firm contact with a wire rendered strongly active, and activity begins at the part touched, and moves much slower than in the tube No. 2, as shown by the rising bubbles.

In pure nitric acid the allotropic change in the wire sometimes moves very slowly, and sometimes after advancing a short distance from the point of contact of the exciting wire, it remains stationary, leaving a portion of the wire entirely inactive in the solution, while the remaining part is being rapidly dissolved by intense chemical action. Fig. 4. In some experiments, in tube No. 1 the allotropic change progressed at the rate of about one inch in twelve seconds, while in tube No. 2 it progressed at the rate of one inch in two seconds, and in tube No. 3 the rapidity of the change was so great that it seemed instantaneous.

In nitric acid, sp. gr. ranging from about 1.380 to 1.390, the allotropic change can be so governed that there will be pulsations of the active change following one another from the point of contact with an active wire; and under certain conditions these pulsations can be made to follow, the first a short distance, as one-quarter inch, the next, half inch, the next, three-quarter inch, and so on, each allotropic pulsation going farther than that preceding it. These pulsations may follow each other slowly, or at an interval of one or two seconds, or they may become more rapid, so that the intervals will be scarcely distinguishable, and still more rapid, to apparently constant action. Is it possible that all chemical activity goes on with successive intervals of activity and passivity, yet undistinguishably rapid, and *thus* produces in conductors rapid molecular movements which we call electricity?

An inactive wire is made active by even slight friction or a blow Wiping it will render it active. A current of electricity will also render it active. Let

the wires of platina P and N, Fig. 5, be arranged so as to be conveniently closed with the poles of a galvanic battery.

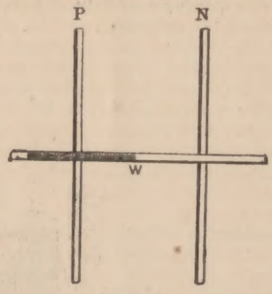

Fig. 5.

Across these lay the iron wire *w*, which has previously been rendered inactive by dipping into pure nitric acid It is bright when laid there, and still wet with acid, but immediately on closing the circuit so that the electric current traverses the wire *w*, it becomes active, an allotropic change progressing from the positive pole, as shown by the acid on its surface becoming dark as it acts upon the iron.

As a law, this allotropic change begins at, and progresses both ways from, the positive pole, and moves the entire length covered with acid; but modifying conditions cause exceptions as to the point where the allotropic change begins. For instance, if the platina wires P, N, are the terminal conductors of a galvanic or faradaic current so weak that of itself it does not *readily* render the iron wire crossing them active, then that part of the wire which has been subjected to the more, however slight, attrition or concussion when laying it across, is first thrown into action.

That the electric current itself, without any attrition or concussion, has power to render the wire active, is demonstrated by using a battery of a dozen strong galvanic cells, and laying the inactive wire *carefully* across the platina wires P and N while the circuit is open in *another part.* The iron wire retains its inactive condition till that *other part* of the circuit is also closed, when immediately and always at the positive pole the allotropic change commences.

3. Now let us arrange the conditions so as to make the artificial nerve actually do what is done by the nerve of a living body. We take a vessel, as glass, containing nitric acid, specific gravity 1.250, and place within it a porous cell containing nitric acid, sp. gr. 1.399. In each of these cells we place a strip of sheet-iron six inches long and one inch wide, which has been rendered inactive by the means previously stated, and each strip of sheet iron has a wire conductor brought into relation with a certain metallic helical arrangement which is also supplied with conductors that are grasped in the hands of the human living subject. No effect is yet produced. We take an iron wire one-eighth of an inch in diameter, which also has been rendered inactive by being dipped in nitric acid, specific gravity 1.399. With this we touch either of the sheet-iron strips below the surface of the acid, and still no effect is produced. But by rubbing this wire briskly for a few seconds, and with it again touching the strip of sheet iron below the surface of the acid, sp. gr. 1.250, immediately there is excited an influence which is transmitted by the conductors to the helical arrangement, where it is modified and carried onward through the arms of the living human subject, the muscles of which contract powerfully beyond his control.

We have seen that the allotropic changes moved along the wire rapidly or slowly, according to certain conditions, one of which was variation in the specific gravity of the nitric acid surrounding it. Now in certain conditions the nervous influence in the living nerves of the body moves quite slowly. In the Medical and Surgical Reporter of Jan. 4th, 1873, Dr. Meredith Clymer refers to a case of loco-motor ataxia, where the application of heat or a pin was felt *many seconds after*. Longet states that by the irritation of both vagus nerves the muscles of the stomach contract *after five or six seconds*.

Now let us make further reference to the substance of the nerves of a living body. Blood must be supplied to the nerve as one condition of its activity, and human blood contains iron, which is a substance highly susceptible of allotropic changes. Also the medullary substance, myeline, or the white substance of Schwan, which surrounds the central axis or band, as previously stated, is an albuminoid body, which contains Carbon, Hydrogen, Nitrogen, Oxygen, Sulphur, Phosphorus. All of these are bodies that exist in different states. Carbon, as we have seen, has three noted differences. The gases, in chemical combinations, are fluids or solids. Oxygen and nitrogen are the elements of nitric acid, and both sulphur and phosphorus exist in different allotropic conditions. Oxygen and hydrogen combined are water, which can readily change specific gravities, and so vary susceptibilities to rapid or slow action.

According to R. D. Thomson, the brain contains a peculiar acid, which he calls cerebric acid, which contains nitrogen and phosphorus; this is mixed with an *albuminous* substance, with an *oily acid*, the oleophosphoric acid, with cholesterine, and finally with small quantities of oleine and margarine, and of oleic and margaric acids. Anhydrous oleic acid is carbon, hydrogen and oxygen, having the formula $C_{26}\ H_{33}\ O_3$. Anhydrous margaric acid is carbon, hydrogen and oxygen, having the formula $C_{34}\ H_{33}\ O_{37}$.

If the nitrogen and oxygen and hydrogen existing in the nerve, were all in the form of nitric acid and water, the influence would be destructive rather than appropriate to fulfill the regulated uses of the nervous functions; but the combinations in which they enter, forming other substances, from which these elements may be eliminated in a manner regulated to the very small amount required, manifest the perfection of their adaptability for the most delicate and exceedingly varied adjustments individually requisite for the quality and degree of effect required. The elimination of phosphorus, etc., through nervous action from its special associations in the nervous substance, has attracted much attention.

Thus we find that brain and nerve substance are composed of elements susceptible of an exceedingly great variety of combinations and allotropic expressions, capable of being exercised in the various duties they have to perform.

Elective Uses of Certain Ranges in the Qualities of Electricity.

The vibratory movements excited in the molecular particles of metallic wires, or in the ether contained in them, which movements are called *electricity*, have differences in their physical effects according to the character of those vibrations, and they are proved to have different physiological effects also. Vibratory or wave motions in particles of air or of ether, giving sound, heat, light, and chemical effects, have vast differences in their physical and physiological effects, and, by way of comparison, before going farther, let us consider these.

Very different effects are produced by merely different characters of vibratory or wave motions in the same medium. Long waves in the air produce sounds of a low pitch, and short waves sounds of a high pitch, and there are waves so short as to produce no effect on the human ear.

So in regard to the waves in the ether; one character of wave will produce heat and not light, another light and not heat; different characters of waves produce the different colors as shown in the spectrum, and a still different character of the waves produces certain actinic or chemical effects, which are quite different from the effects produced by heat. And these different characters of ethereal wave motions are principally differences in the rapidity and lengths of the same, the rays of heat being produced by waves slower, but of greater amplitude, then as the rapidity increases, and the amplitude diminishes, we have red, orange, yellow, green, blue, indigo, violet and the actinic rays which are also invisible.

The heat, the colored and the actinic rays, to a certain extent, overlap one another in the spectrum; also different kinds of refracting media give different degrees of refrangibility of the rays of heat compared to the color rays—

through a	Water prism it is found in the yellow,			
	Sulphuric Acid	"	"	orange,
	Plate glass	"	"	middle of the red,
	Flint glass	"	"	beyond the red.

A cell of alum intercepts the rays of heat, but allows the light to pass, while a cell of iodine dissolved in bisulphide of carbon intercepts the luminous, but allows the calorific rays to pass.

The heat rays, if concentrated on a piece of platinum coated with platinum black, are accelerated so as to become visible; and likewise rays, passed through a solution of sulphate of quinine, and some other substances, are retarded so as to become visible—the visibility of the latter is called *fluorescence.* It is exhibited in an aqueous solution of horse-chestnut bark, by many compounds of uranium; a decoction of madder mixed with alum gives a yellow or orange *yellow* fluorescence. Tincture of tumeric ana yellow thorn-apple seeds diffuse a *greenish* light—all caused by lowering the refrangibility of the invisible actinic rays so as to make them visible.

As to the power of coloring plants green, Robert Hunt found that every variety of plant he employed appeared to be influenced by different rays. Cress and mustard became green most rapidly in the green ray, mignionette in the yellow and peas in the blue—the influence was most decided between the mean orange and the mean blue ray, and plants became green more slowly in the red than in the blue ray. Guaiac resin, which is turned blue by exposure to sunlight, is not at all affected by any of the visible rays of the spectrum, the action beginning only in the ultra violet, and the maximum being situated a long way beyond the visible spectrum.

Light heat and actinism are common to every ray, the difference being only proportional; a yellow medium gives most light and less actinism, while a blue medium gives more actinism and less light.

Light hinders the germination of seeds. Actinism quickens germination. Light effects decomposition of carbonic acid in growing plants, which absorb carbon and give off the oxygen. Light and actinism, independent of the calorific rays, prevent the development of the reproductive organs of plants. The heat rays, corresponding with the extreme red, facilitate the flowering of plants and the perfecting of their reproductive principles.

Many bodies, under peculiar circumstances, are thrown into such a state of vibration that they emit light without perceptible heat, called phosphorescence. Decaying bodies, flowers of certain living plants, etc., exhibit this quality. Different rays of the spectrum differ as to their power of producing phosphorescence. Electric light produces phosphorescence more actively than the solar rays.

Very strange are all the foregoing varied effects when we consider that the calorific, luminous, chemical and phosphorogenic rays are all substantially the same in their nature, being each and all produced by movements of the ether, those movements differing principally in rapidity and degree.

The functional activity, not only of muscles, but of nerves also, is influenced, by currents of electricity. And as a motor nerve electrically excited causes a muscle to contract, so also, as shown in standard works on physiology, regulated electrical excitation of the respective nerves presiding over the organs of digestion, secretions, circulation, etc., influences their functional activities. Now we should look also for electrical influence over the functional activities of other organs themselves without regard to presiding nerves, just as much as we look for electrical excitation to influence a muscle directly without regard to its presiding nerve. It seems that we must recognize this when we consider the fact that *each element* in the organism has its *individual activity*, which is evident from the comparison of vegetable and animal organizations, the independent development of tissues after the evolution of the germ, physiological dissections on the living animal, the mode in which poisons act, etc., etc.

A very important fact to consider is that the different organs of the body have their gradations as to susceptibilities to different qualities of electricity. An induced current on a coil of wire of a certain ratio as to length, thickness, number of convolutions, with certain other modifying conditions, electrically excited, will cause powerful muscular contractions, but will produce very little light to the eye. Now if we arrange another coil of wire so as to yield a current of much higher intensity and less quantity, this latter conditioned coil being excited in the same manner as in the former case, will have less effect on the irritability of muscular tissue, but will produce light to the eye, when the

current is regulated to be so weak as not to produce pain, will, when properly used, have a more soothing effect upon the nerves—will better relieve nervous headache, and cause deeper inspirations by properly influencing the medulla oblongata and cervical spine, the negative, with large wetted sponge, being the preferable electrode on those regions.

Now if another coil, conditioned for considerable greater quantity than the first mentioned, but far less intensity, ranging from A B to A C, in Dr. Kidder's improved apparatus, it will produce no light whatever to the eye, even when the current is strong enough to produce pain—it will not contract the muscles so powerfully—it will not so well soothe pains in the system; but by its influence, using the positive as the preferable pole, it will exercise a remarkable specific effect in restoring to their normal condition muscles that are sore from the effects of over use and strains, and all allied conditions.

In this respect a more special contrast in the differences of these qualities will be here presented. Placing the negative pole farther towards the extremities, and using currents of sufficiently high intensity and low quantity, graded to the strong muscular contracting tendency, as in the current A D, Dr. Kidder's improved instrument, a strong power can make the muscles sore and lame. Now using the current from A B or A C with light power, and using the *positive* pole upon the lamed muscles, the soreness and lameness will be almost immediately cured, when otherwise it would not pass away for a considerable length of time. These results became known to Dr. Kidder first by many trials upon himself, which have been amply corroborated by trials upon others. Inflammatory excitements, as burns, etc., wil be better relieved by the negative, using very *large* surface of sponge, or what is better, having the part in water with the negative electrode, and using especially currents of high intensity and low quantity, as A E of the improved instrument.

Further considering this subject, we may contrast the two *general* processes, which are the opposite of each other, that take place in the living body. One is nutrition of the tissues of the various organs, and the other is the functional activity of those organs, which wears away the tissues; and they again call for more nourishment, without the supply of which their activity would soon cease. The assimilation of nourishment in the tissues takes place more during the night, while the body is at rest. The using up of the tissues takes place more during the day, when the body is active. Now the relations of electricity to these two conditions appear to be these. Electrical currents, especially of the induced order of *high intensity* and *low quantity*, act comparatively more in producing functional activity of the various organs of the body, though somewhat different range of the ratio of quantity and intensity of the current is best adapted for the different organs, which is shown by the different ratio required to best excite the motor and the visual functions. But currents of comparatively lower intensity and a higher quantity are the better range, and move forward more directly, the nutritive processes in the various organs.

In the former case it is better to excite the various organs with the negative pole, having the positive more central toward the medulla oblongata, while in the latter case it is preferable to use the current in the opposite direction.

Now if a wire be conditioned so that the vibration of its particles should be similar to those produced in ether by white light, why should it not produce light to the eye? Why should it not excite whatever substances are in the eye and brain that correspond in their effects to the fluorescence produced in sulphate of quinine, by the lowering of the refrangibility of the invisible actinic rays so as to make them become visible rays, and why should they not also exhibit phenomena of colors?

So we find that the functional aclivity of different organs of the body, and the processes of their repair, respond better to different characters of vibratory movements which we call electricity.

The Exercise of the Visual Functions.

By using the proper electric currents, the eye and the brain may indeed experience phenomena, like to the reception through the eye of white light, colored light, and light of the characters called fluorescence and phosphorescence.

Dr. Kidder has made costly Electrical Apparatus, having the current ranged in quality to produce more special varied optical phenomena, which are not observable effects of his more ordinary apparatus. One of these instruments was placed in the hands of an artist, for him to illustrate the visual phenomena produced by the current, and the following are the results which he gave, after thorough experiments with currents of pretty strong power:

Fig. 1. Placing the sponge to the bone over the left eye softly, observed lines of light, which were sometimes straight, with slight flashes crossing them, (all white light.)

Fig. 2. Now by pressing hard against the bone on the right side of the right eye, there is a great change. Immediately globes of a red color shoot from the right to the left slowly, and blue globes (I) will burst asunder like meteors and

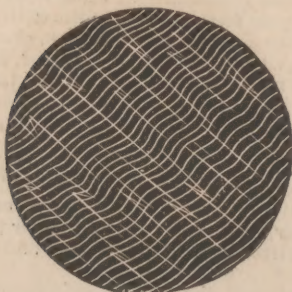

Fig. 1.

Fig. 2.

instantly disappear; small yellow star-like shapes (3) will continue to travel up and down, while instantaneous white flashes pass through the field. There is also a slight ringing in the ear.

Fig. 3. Moving the sponge across the forehead (at eyebrows) to the left eye, there are vivid flashes (2), while yellow spots move rapidly across, dying out near the centre (3), while a bright light (1) at the left moves up and down. Fig. 3 is on first page.

Fig. 4. Sponge over the right eye, there is a yellow light on the left side, dying out at the centre, trembling as it dies into darkness. There is a humming noise in the right ear.

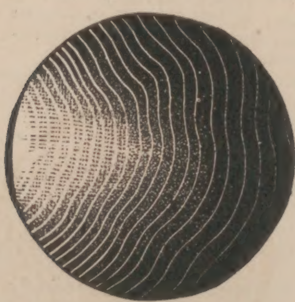

Fig. 4.

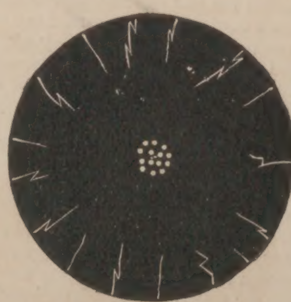

Fig. 6.

Fig. 5. Rainbow colored globes slowly moving from left to right, while flashes cross from left to right: the sponge is now on the eyelid and considerable force of the current (7 minutes) pressing hard. Now placing sponge on the left eye, Fig. 6 came to view. Fig. 5 is on first page.

Fig. 6. Sponge on left eye, pains run over the head, the short yellow flashes appeared, while in the centre were light blue spots rapidly appearing and disappearing. (Strong power of the current.)

Fig. 7. After resting ten minutes, the sponge was placed in the corner of the left eye by the bridge of the nose,—strong power of the current was applied, when I received a violent shock and a reflection, as sunlight on the ceiling is reflected from a basin of water, moving at an angle up and down, the centre ring being the brightest, and dying out as they came near to the surface of the field of vision.

Fig. 8. The current was now made very weak, and pressing the sponge on centre under the eye, an object like a coiled snake appeared, with flashes of light around it. These became more vivid by harder pressing with the sponge, and they moved constantly, dying out at the tail with a flash, the *base of supply* being the centre *a*.

Fig. 7.

Fig. 8.

Fig. 9. Feeling a pain on the top of my head, I removed this in a very short time by using the proper current, in the manner recommended by Dr. Kidder. Then placing the sponge on the right corner of the right eye, and making the current strong, globes (*a*) of a rainbow-colored appearance moved slowly from the left to the right, but died out as they came in contact with (*b*), another ball or globe of light the same size but different in character, as the light in (*b*) radiates from the centre to a bright yellow ring. As the two globes met, the (*a*) changed into purple and disappeared, while (*b*) moved downward, keeping on the right side (*c*), raining dark blue spots, and making an instantaneous disappearance.

Fig. 10. A trembling light, and bright spot (2), dying as it leaves the ring—and by rubbing the sponge from left to right the form 3 appeared ; half red and blue shot out with a strong light at the left side, but very small. This was followed with small flashes (4), the current being kept to the right eye thirteen minutes. Fig. 10 is on first page.

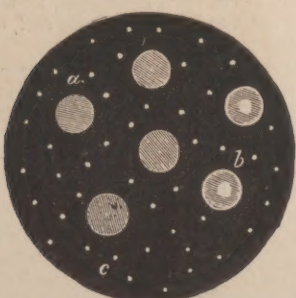

Fig. 9.

Fig. 11.

Fig. 11. Placing the sponge now to my left eye, and making the current strong, I saw stars in about four seconds. Rings vibrating came from the ends, growing weaker as they approached the centre, where they died out en-

tirely. This was very beautiful. It commenced with yellow at the first ring; about the fourth or fifth ring they became red, and disappeared in a faint blue.

Fig. 12. Producing this, I placed the sponge wetted with water to my right eye, and in a few seconds the spots (*c*), of a blue color, first came to view; then moving the sponge to the right side of the eye, bars appeared and disappeared; these were of different colors; there were sometimes from three to four bars upon one another, in the manner in which crystals are observed in wine. Moving the sponge to the orbit and pressing hard, (*a*) came to view and moved to an obtuse angle the same as in Fig. 7. **Fig. 12 is on first page.**

Fig. 13. Two hours after the former experiment I used the current again, moving the sponge in a line from temple to temple, running over the forehead, when on a sudden I placed the sponge over the orbit of the right eye, and made the current strong. There appeared a bright light, dying out in the centre, when it changed to an oval shape as bright as a calcium light (*a*). In about two seconds a blue ring formed around (*a*) and enlarged, when another yellow ring formed around the blue (*b*), dying out at the edges (*c*); then it moved as a pendulum of a clock (*á á*), when flashes or small jets came from the rim, finally dying out. Now moving the sponge to the corner of the eye by the bridge of the nose, and pressing, a general explosion took place, as shown by the **Fig. 14.**

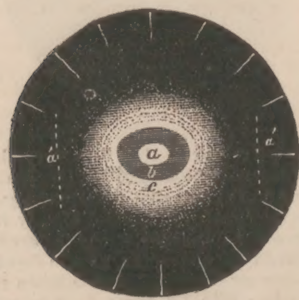

Fig. 13.

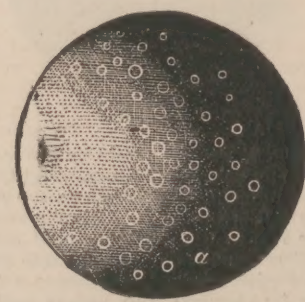

Fig. 14.

Fig. 14. A white light, dying out at the centre of the field, with small rings running from right to left, and dying before reaching the rim. These were of a red color, and blue when dying; a few waving lines also were faintly visible.

The function of hearing is best exercised by currents of high intensity though of low quantity. The current on a comparatively short and thin wire, is to the sensation what may be called sharp, cutting. The changed condition, by using a condenser so as to lengthen the spark of the current from a definite coil, does not extend to produce specially different physiological results.

Through its allotropic powers, the nervous system, not only presides over the action of organs and the replenishing of their wasting tissues, but also to a great extent, it provides remedy for adverse adventitious impressions, as poisons, etc. For example, typhoid fever is seldom taken except when the nervous system is in a somewhat depressed state; and always when any kind of disease is prevalent, the condition of the nervous system very much determines whether attacks by that disease will be experienced, which is a fact well known. By such offices of the nervous system, which seem almost miracles, like a guardian angel, undoubtedly we are daily protected from many unseen and unknown dangers surrounding us.

Coils of wire different in their proportions as to length, thickness and number of convolutions, etc., are so different as mediums for the electrical vibrations that the electricity from each produces different effects.

Helices producing quantity currents give a deflagrating spark, shown best when one electrode is iron, and the other a metallic point drawn across it. The following diagram shows the tests, in this manner, of currents differing in quantity and tension. The two lines, (Fig C,) show the variations in the quality of

spark produced by currents differing in their ratios of quantity and tension, tested by drawing a metallic point, as an electrode, over a piece of rough iron or steel as another electrode. Of these two, the first line shows the quantity influence which decreases (from left to right in the diagram) as the helices are varied to produce induced currents of diminished quantity, though of increased tension.

Fig. C

But the kind of spark to indicate the increased tension is not shown in this line, but is shown in the second line; it is a small white spark which does not deflagrate, increasing (from left to right in the diagram) as the helices are varied to produce induced currents of increased tension though of diminished quantity.

In regard to the artificial nerve, previously mentioned in this work, it may be here stated that the conditions may be modified with substantially the same principles; the specific gravity of the acids may be somewhat varied—one quality of acid alone can be made to answer for both the inactive element and the element thrown into action. Other elements, omitting iron, may be substituted for the one to remain inactive and the one to be thrown into action. An exciter, as an iron wire not rubbed, but already active, may be used—attrition or concussion with other substances, and even an electric current, may be used as excitors of the allotropic influence.

As the influences of the nerves are of manifold character in their presidency over motion, secretion and digestion; even so in regard to sensation—their influences are also manifold; for there are many characters of sensation,—smarting, itching, pricking, different characters of aching, stinging, etc., as pain produced by heat is different from pain produced by cold. And the sensations of hunger and thirst are different from each other. The sensations of taste appear illimitable in their variety, even as that of smell also, we cannot limit; for it is not known how many different substances affect this sensation differently—all these through the nervous system.

And even as different qualities of sensation are brought to the brain by the nerves, recognizing differences in the character of the stimuli, even so we may look for a controlling nerve force going out from the brain in certain conditions, which represses sensations from certain stimuli, which, under ordinary circumstances, produce pain. For example, soldiers, in the excitement of battle, are often unconscious of severe wounds, from the absence of pain till after the mental excitement has passed away.

Now there is a range in the quality of induced electricity which, to a certain degree, excites this *repressing power* of nervous influence *over* that which is the sensation of pain. Induced currents of a high intensity and low quantity, if of the proper range in this respect, as A D, or more especially A E, in Dr. Kidder's Improved Apparatus, and properly used, will, in its mixed effects on the various nerves, act more to repress pain than to excite sensation.

The author has made reference to the allotropic influence as the *nerve influence.* The conditions may be so arranged that the allotropic changes will move at precisely the same rapidity as those of the vital influence along the nerves which produces motion and sensation. But as these allotropic changes, under certain conditions, give rise to currents of electricity, we must be prepared, *if such conditions are found in the nerve*, to accept the view that the *electricity* which is produced by the allotropic influence may *execute* the vital mandates by exciting other allotropic changes in the elements of organs and parts; for we have seen (page 6) that electricity produced allotropic changes, and allotropic

changes, as effected in the artificial nerve, gave rise to those vibrations in conductors which we call electricity, which could be made to produce motion, sensation and other vital phenomena. The conditions of the artificial nerve were so arranged that, when a certain allotropic state was established, that artificial nerve *was a galvanic battery*. Now a nerve belonging to the living organism, appears to have precisely the same conditions—we have the neurilemma to contain the elements, we have the myeline or the white substance of Schwan as one of the elements, and we have the axial band as the other element. Therefore, the nerve is not only a medium of allotropic changes and a conductor of electric currents, but it also appears to be *itself a galvanic battery*, which is active or inactive, according to the allotropic conditions of its elements.

How slight an influence is sufficient to cause allotropic transformations and consequent powerful chemical unions may be instanced by means of sounds of certain degrees of pitch causing the explosion of certain substances.

So we find that the allotropic condition which moves slower than electricity is, in one of its offices, approximately as it were, a switch to throw the nerve, as a galvanic battery, *in* and *out* of action! As we know that electricity can excite allotropic changes, and that allotropic changes produced by any means, can excite electricity,—it seems that in either case we have explanation enough to account for the allotropic changes necessary to bring about the activities of functions and the nutrition of parts.

But the allotropic transformation was in somewhat different relation to the battery from that merely of a switch to connect and disconnect the poles. The elements of the nerve is not a galvanic battery *until made so* by the allotropic change; in one moment the nerve is a galvanic battery, and in another moment it is not; therefore this allotropic change is the primordial force *within the body* for the establishment of the nervous influence, though electricity produced thereby may be the agent to *execute* the design by establishing certain other allotropic conditions in the elements of muscular tissue, which cause contraction, and in the brain to produce sensation, and in other organs to advance the processes of secretion, digestion, assimilation, etc., etc. Allotropism the primordial force within the body—within the constitution of the organs concerned—but outside of the body a thousand agencies operate as impressions to establish these allotropic changes; they are the stimuli which excite us to action, quicken our hopes, and furnish us constantly with the evidences whereby we know that we live.

The question may be asked, Why are different ratios of quantity and intensity of induced electricity necessary severally to excite the functional activities of vital parts? It may be answered that chemical changes are effected by vital activities, the elements concerned being *electrolytes*. The electrolytic activities in the different organs are varied, and their susceptibilities to allotropic changes are different; therefore a different ratio of quantity and intensity of electricity is required to bring them severally into action.

The author has endeavored to present this seemingly interesting subject with consistent brevity, and at the same time he has made such repetitions of the subject, with varied phraseology, as is perhaps requisite to be well understood, considering the imperfection of his language.